

CLAIMS

1. A system for sensing position comprising:
 - a transmitting device operable to transmit a radio signal;
 - 5 at least two receiver units in spaced relation to each other and each operable to receive a different version of the radio signal; and,
 - an electronic circuit coupled to the receiver units and operable to determine a location of the radio transmitting device in relation to the receiver units based on a comparison between each the different version of the radio signal.
- 10 2. The system of claim 1 further comprising at least one additional radio transmitting device, each of the radio transmitting devices operable to transmit a radio signal orthogonal to each other the radio transmitting device, the electronic circuit further operable to distinguish each of the radio transmitting devices from the other based on the orthogonal signals, the electronic circuit being further operable to determine a location of the radio transmitting devices substantially simultaneously.
- 15 3. The system according to claim 2 wherein an antenna associated with each of the receiver units are spaced apart at a distance of about one-half of a wavelength of the radio signal.
4. The system according to claim 2 wherein the radio signals are based on a spread spectrum technology.
- 20 5. The system according to claim 4 wherein the spread spectrum technology is selected from the group consisting of direct sequence spread spectrum signals, frequency hopping spread spectrum signals, time hopping spread spectrum signals, linear frequency sweeping (chirp) signals, and hybrid signals.
6. The system according to claim 2 wherein the radio signals are based on code division multiple access (CDMA) and the orthogonal codes are unique pseudo-noise (PN) codewords assigned to each of the transmitting devices.
- 25 7. The system according to claim 1 wherein the different versions of the radio signal are identifiable via a phase shift between the versions.
8. The system according to claim 7 wherein the different versions of the radio signal are identifiable using at least one of a radiated signal strength technique and a carrier phase-delay technique.
- 30 9. The system according to claim 1 wherein the transmitting device is affixed to a pointing device and the electronic circuit is coupled with an input device on a personal computer

having a display device and such that the pointing device is operable to move a cursor on the display device.

10. The system according to claim 9 wherein the pointing device includes at least one button for user actuation and the radio signals is based on code division multiple access (CDMA) and transmitting device is assigned a pseudo-noise (PN) codeword, and wherein an actuation of the button is transmitted to the receiver units via using one of the techniques of inverting the PN codeword for at least one bit-period, and switching to a different PN codeword for at least one bit period.
11. The system according to claim 1 wherein a power supply incorporated into the transmitting device is selected from the group consisting of a battery, a solar cell, a coil operable to receive energy from an EM powering field radiating proximal to the power supply, and a coil operable to induce electrical energy from a magnetic field by mechanical motion.
12. The system according to claim 1 comprising only two of the receiver units and the location is expressed in a single-dimension.
13. The system according to claim 1 wherein at least one of the transmitting device and the receiver units remain fixed during operation..
14. The system according to claim 1 comprising three of the receiver units arranged in a triangular format, the electronic circuit operable to receive a first input from a first pairing of the three receiver units and further operable to receive a second input from a second pairing the three receiver units, the pairings having only one of the receiver units in common, the electronic circuit further operable to determine a two dimensional position of the transmitting device based on a comparison of the first input and the second input.
15. The system according to claim 1 comprising four of the receiver units arranged in a rectangular format, the electronic circuit operable to receive four separate inputs from four respective pairings of the four receiver units, the electronic circuit further operable to determine a three dimensional position of the transmitting device based on a comparison of the separate inputs.
16. The system according to claim 15 wherein the rectangular format is a plane arranged around a periphery of a computer display.
17. The system according to claim 1 comprising eight of the receiver units arranged in a cube, the electronic circuit operable to receive eight separate inputs from eight respective pairings of the eight receiver units, the electronic circuit further operable to determine a three dimensional position of the transmitting device in relation to the cube based on a comparison of the separate inputs.

18. The system according to claim 1 wherein the electronic circuit comprises a channel pair processor connected to the receiver units, a detector & position calculator connected to the channel pair processor, and an output device for presenting the location to an electronic peripheral attachable to the output device.
- 5 19. The system according to claim 1 wherein the electronic peripheral is a computer and a display device, the computer being configured to present a representation of the location on the display device.
- 10 20. The system according to claim 18 wherein the channel pair processor comprises an I/Q demodulator coupled to the receiver unit to receive input therefrom, the channel pair processor further comprising an analog-to-digital converter coupled to the I/Q demodulator for converting analog signals therefrom to digital signals; the channel pair processor further comprising a phase data calculator for determining amplitude and phase information from the digital signals and for outputting the amplitude and phase information to the detector & position calculator.
- 15 21. The system according to claim 20 wherein the system is based on CDMA and the detector & position calculator comprises:
- a CDMA processor for receiving the amplitude and phase information;
 - a transmitter detector coupled to the CDMA processor and for determining an identity of the transmitting device;
 - 20 a data signal extractor coupled to the transmitter detector for determining any specific data embedded in the radio signal respective to the transmitting device; and,
 - a device locator coupled to the data signal extractor for determining a position of the transmitting device.
- 25 22. The system according to claim 1 wherein the transmitter device comprises a power supply, orthogonal code generator, a VCO generator interconnected by an RF signal modulator; the transmitter device further comprising a pulse shaping module for shaping a waveform output from the RF signal modulator; the transmitter device further comprising an antenna connected to an output of the pulse shaping modulator for outputting the radio frequency.
- 30 23. The system according to claim 22 wherein the orthogonal code generator generates PN codes and is comprised of a PN-code chip coupled to a microprocessor, the PN-code chip for instructing the microprocessor which PN code is to be generated for the transmitting device.

24. The system according to claim 23 wherein the orthogonal code generator further comprises a switch for selectively changing the PN-code to another PN-code when the switch is activated.
25. The system according to claim 1 wherein the transmitting device is incorporated into a computer interface selected from the group consisting of a mouse, a tilt-joystick, a pointer controller, a six-degree-of-freedom interface, and a gesture interface.
26. The system according to claim 1 wherein the transmitting device is incorporated into a surgical instrument.
27. The system according to claim 1 wherein the transmitting device is incorporated into an industrial robot.
28. The system according to claim 1 wherein the receiver unit comprises an antenna and a receiver element.
29. The system according to claim 1 wherein the receiver element comprises a low-noise amplifier connected to the antenna, a bandpass filter connected to the low-noise amplifier, and an intermediate frequency amplifier connected to the bandpass filter for outputting to the electronic circuit.
30. A transmitting device operable to transmit a radio signal, the transmitting device for communication with at least two receiver units in spaced relation to each other and each operable to receive a different version of the radio signal in order to determine a position of the transmitting device via an electronic circuit connected to the at least two receiver units.
31. A receiver unit operable to receive a radio signal transmitted from a transmitting device; the receiver unit for placement in spaced relation to another substantially identical receiver unit such that each receiver unit is operable to receive a different version of the radio signal, the receiver unit for connection to an electronic circuit connectable to both of the receiver units, the electronic circuit being operable to determine a location of the radio transmitting device in relation to the receiver units based on a comparison between each the different version of the radio signal.
32. A method for sensing position comprising:
receiving a first version of a radio signal from a transmitting device;
receiving a second version of the radio signal; and,
determining a location of the transmitting device based on a comparison of the first version and the second version.
33. The method of claim 32 further comprising the steps of:

receiving first version of at least one additional radio signal from at least one additional radio transmitting device, the at least one additional radio signal being orthogonal to the radio signal;

receiving a second version of the at least one additional radio signal;

5 determining a location of the at least one transmitting device based on a comparison of the first and second versions of the at least one additional radio signal.

34. The method according to claim 33 wherein antennas used to perform the receiving steps are spaced apart at a distance of about one-half of a wavelength of the radio signal.

10 35. The method according to claim 33 wherein the radio signals are based on a spread spectrum technology.

36. The method according to claim 33 wherein the spread spectrum technology is selected from the group consisting of direct sequence spread spectrum signals, frequency hopping spread spectrum signals, time hopping spread spectrum signals, linear frequency sweeping (chirp) signals, and hybrid signals.

15 37. The method according to claim 33 wherein the radio signals are based on code division multiple access (CDMA) and the orthogonal codes are unique pseudo-noise (PN) codewords assigned to each of the transmitting devices.

38. The method according to claim 32 wherein the different versions of the radio signal are identifiable via a phase shift between the versions.

20 39. The method according to claim 38 wherein the different versions of the radio signal are identifiable using at least one of a radiated signal strength technique and a carrier phase-delay technique.

40. The method according to claim 32 wherein the transmitting device is affixed to a pointing device and the electronic circuit is coupled with an input device on a personal computer having a display device and such that the pointing device is operable to move a cursor on the display device.

25 41. The method according to claim 40 wherein the pointing device includes at least one button for user actuation and the radio signals is based on code division multiple access (CDMA) and transmitting device is assigned a pseudo-noise (PN) codeword, and wherein an actuation of the button is transmitted to the receiver units via inverting the PN codeword for one bit-period.

30 42. The method according to claim 32 wherein a power supply incorporated into the transmitting device is selected from the group consisting of a battery, a solar cell, a coil operable to receive energy from an EM powering field radiating proximal to the power

supply, or a coil operable to induce electrical energy from a magnetic field by mechanical motion.

43. The method according to claim 33 the orthogonality is effected through PN codes unique to each transmitting device.

5 44. A system for sensing position comprising:

at least two transmitting devices each operable to transmit an orthogonal CDMA radio signal;

10 at least two receiver units in spaced relation to each other and each operable to receive a different version of each of the radio signals, the receiver units comprised of an antenna and a receiver element; and,

an electronic circuit coupled to the receiver element and operable to substantially simultaneously determine a location of each of the radio transmitting devices in relation to the receiver units by distinguishing the transmitting devices based on the orthogonality and based on a comparison between each the different version of each respective radio signal.

15 45. The system according to claim 44 wherein the antennas associated with each of the receiver units are spaced apart at a distance of about one-half of a wavelength of the radio signal.

46. The system according to claim 44 wherein the orthogonal radio signals codes include unique pseudo-noise (PN) codewords assigned to each of the transmitting devices.

20 47. The system according to claim 44 wherein the different versions of the radio signal are identifiable using at least one of a radiated signal strength technique and a carrier phase-delay technique.

48. A radio transmitting system for identifying and locating one or more radio transmitting devices in a radio transmitting area, including:

- 25 • a signal propagating medium for conducting signals throughout the radio transmitting range;
- at least one of the radio transmitting devices including means for producing a radio transmitting signal and coupling the signal to the propagating medium, the radio transmitting signal comprising a spread spectrum signal;
- each radio transmitting signal including a unique code identifying the respective device;
- 30 • signal receiving means associated with the sensing area and connected to the propagating medium to receive at least one radio transmitting signal from the one or more radio transmitting devices; and,

- means for decoding the radio transmitting signal to identify at least one of the radio transmitting devices.

49. The radio transmitting system of claim 48, further including means for determining the position of at least one of the radio transmitting devices in the radio transmitting range.

5 50. The radio transmitting system of claim 48, wherein the one or more radio transmitting devices are active devices.

51. The radio transmitting system of claim 50, further including means for generating an energy field in the propagating medium within the radio transmitting range.

10 52. The radio transmitting system of claim 51, wherein the energy field includes a spread spectrum signal component.

53. The radio transmitting system of claim 51, wherein each of the radio-transmitting devices includes a means to receive a signal through the EM energy field for active radio transmitting device operation.

15 54. The radio transmitting system of claim 51, wherein the energy field includes an EM field or a magnetic field.

55. The radio transmitting system of claim 54, wherein the propagating medium comprises free space in the radio-transmitting range.

56. The radio transmitting system of claim 54, wherein the propagating medium comprises an occlusion in the radio-transmitting range.

20 57. The radio transmitting system of claim 52, wherein the spread spectrum signal component is a direct sequence spread spectrum (DSSS) signal.

58. The radio transmitting system of claim 52, wherein the spread spectrum signal component is a frequency hopping spread spectrum (FHSS) signal.

25 59. The radio transmitting system of claim 52, wherein the spread spectrum signal component modulation is Amplitude Shift Keying (ASK).

60. The radio transmitting system of claim 52, wherein the spread spectrum signal component modulation is Frequency Shift Keying (FSK).

61. The radio transmitting system of claim 48, wherein the unique codes of the one or more radio transmitting devices are orthogonal codes.

30 62. The radio transmitting system of claim 48, wherein the one or more radio transmitting devices are active devices that generate a radio transmitting signal.

63. The radio transmitting system of claim 48, wherein the radio transmitting signal is an EM signal.

64. The radio transmitting system of claim 63, wherein the propagating medium comprises free space in the radio-transmitting range.
65. The radio transmitting system of claim 63, wherein the propagating medium comprises an EM reflecting and conducting layer in the radio-transmitting range.
- 5 66. The radio transmitting system of claim 63, wherein the signal receiver means includes a plurality of spaced-apart signal receivers; and the means for determining the position of each of the one or more radio transmitting devices includes means for calculating the received signal strengths and phase differences of the radio transmitting signals passing through the propagating medium to the plurality of signal receivers.
- 10 67. The radio transmitting system of claim 63, wherein the means for decoding and identifying each of the one or more radio transmitting devices includes matched-filtering means for comparing received radio transmitting signals to stored spread spectrum codes of the one or more radio transmitting devices.
68. The radio transmitting system of claim 48, wherein the at least one radio transmitting device
15 comprises a 2-dimensional mouse controller.
69. The radio transmitting system of claim 48, wherein the at least one radio transmitting device comprises a 3-dimensional mouse controller.
70. The radio transmitting system of claim 48, wherein the at least two radio transmitting device comprises a tilting joystick controller.
- 20 71. The radio transmitting system of claim 48, wherein the at least two radio transmitting device comprises a "pointer" controller.
72. The radio transmitting system of claim 48, wherein the at least three radio transmitting device comprises a 6-DOF controller.
73. The radio transmitting system of claim 48, wherein the at least two radio transmitting device
25 comprise a gesture interface controller.
74. The radio transmitting system of claim 48, wherein a portion of the radio transmitting devices include a receiver operable to receive wireless instructions to vary operation of the radio transmitting devices.
- 30 75. A radio transmitting system for identifying and locating one or more radio transmitting devices in a radio transmitting range, including:
- a signal propagating medium for conducting signals throughout the radio transmitting area;

- at least one of the radio transmitting devices including means for producing a radio transmitting signal and coupling the signal to the propagating medium, the radio transmitting signal comprising a spread spectrum signal;
 - each radio transmitting signal including a unique code identifying the respective radio transmitting device;
 - signal receiving means associated with the radio transmitting area and connected to the propagating medium to receive at least one radio transmitting signals from the one or more radio transmitting devices;
 - means for decoding the radio transmitting signals to identify the one or more radio transmitting devices; and,
 - means for determining the position of the one or more radio transmitting devices in the radio transmitting range.
76. The radio transmitting system of claim 74, wherein the at least two radio transmitting device comprises a tilt joystick controller.
77. The radio transmitting system of claim 75, wherein the at least two radio transmitting device comprises a "pointer" controller.
78. The radio transmitting system of claim 75, wherein the at least one radio transmitting device comprises a 2-dimensional mouse interface controller.
79. The radio transmitting system of claim 75, wherein the at least one radio transmitting device comprises a 3-dimensional mouse interface controller.
80. The radio transmitting system of claim 75, wherein the at least three radio transmitting device comprises a 6-DOF controller.
81. The radio transmitting system of claim 75, wherein the at least two radio transmitting device comprises a gesture interface controller.
82. The radio transmitting system of claim 75, wherein a portion of the one or more radio transmitting devices are active devices that generate a radio transmitting signal, and another portion of the one or more radio transmitting devices are active transceiver devices.